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14. ABSTRACT

Soldier-wearable gunfire detection systems (SW-GDS) are important for situational awareness because they provide an estimate of the shooter's location and the trajectory of the bullet. Individual SW-GDS units provide an estimate of the range and bearing to the shooter for each shot, as well as "raw" data that includes time-of-arrival (TOA) and direction-of-arrival (DOA) of the muzzle blast (MB) produced by the weapon and the shock wave (SW) produced by the supersonic bullet. The localization accuracy is improved with data fusion between networked SW-GDS sensor units. We study models for bullet deceleration and develop efficient localization algorithms that

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Report Title

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Soldier-wearable gunfire detection systems (SW-GDS) are important for situational awareness because they provide an estimate of the shooter's location and the trajectory of the bullet. Individual SW-GDS units provide an estimate of the range and bearing to the shooter for each shot, as well as "raw" data that includes time-of-arrival (TOA) and direction-of-arrival (DOA) of the muzzle blast (MB) produced by the weapon and the shock wave (SW) produced by the supersonic bullet. The localization accuracy is improved with data fusion between networked SW-GDS sensor units. We study models for bullet deceleration and develop efficient localization algorithms that explicitly incorporate the deceleration models in the data fusion. Localization algorithms are developed for individual SW-GDS units and fusion of networked SW-GDS units. A statistical analysis of mismatch between the assumed model and actual deceleration is performed, and the localization algorithms are tested with simulations and measured data. The deceleration models and localization algorithms are described in detail in a technical report.

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Sub Contractors (DD882)

Inventions (DD882)

Scientific Progress

A survey of several bullet deceleration models is presented.

For each deceleration model, mathematical expressions are developed that relate the soldier-wearable gunfire detection system (SW-GDS) position and the shooter's position to the measured acoustic data, consisting of time-of-arrival (TOA) and direction-of-arrival (DOA) of the muzzle blast (MB) produced by the weapon and the shock wave (SW) produced by the supersonic bullet. These expressions form the basis for shooter localization algorithms.

In order to exploit SW data for shooter localization, it is necessary to determine the "SW detach range", which the location along the bullet's trajectory at which the SW begins to propagate to the sensor. The SW detach range depends on the bullet deceleration model. We develop efficient algorithms for finding the SW detach range, consisting of closed-form expressions for some deceleration models, and rapidly-converging iterative algorithms for the other deceleration models.

The bullet deceleration model assumed in the localization algorithm may be different than the actual deceleration of the bullet. A statistical analysis of the fusion algorithm is performed to assess the effect of this mismatch in terms of bias and variance of the shooter location estimate.

The "drag force" (DF) bullet deceleration model is the most accurate, based on support from theory and experiments. For the DF model, we provide a complete shooter localization algorithm for individual SW-GDS units as well as a fusion algorithm for networked SW-GDS units.

The performance of the fusion algorithm for shooter localization is evaluated with simulations and field-measured data.

These items are described in detail in a separate document that is submitted as a Technical Report.

Technology Transfer